We claim:

1. A method for producing carotenoids or their precursors using genetically modified organisms of the Blakeslea genus, which method comprises the following steps:

   (i) transformation of at least one of the cells,

   (ii) optional homokaryotic conversion of the cells obtained in step (i) to produce cells in which one or more genetic characteristics of the nuclei are all modified in an identical manner and said genetic modification manifests itself in the cells, and

   (vi) selection and reproduction of the genetically modified cell or cells,

   (vii) cultivation of the genetically modified cells,

   (viii) preparation of the carotenoid produced by the genetically modified cells or the carotenoid precursor produced by said genetically modified cells.

2. The method according to claim 1, **wherein** the cells are from fungi of the Blakeslea trispora species.

3. The method according to claim 1 or 2, **wherein** a vector or free nucleic acids are used in the transformation (i).

4. The method according to claim 3, **wherein** the vector employed in the transformation (i) is integrated into the genome of at least one of the cells.

5. The method according to claim 4, **wherein** the vector employed in the transformation (i) comprises a promoter and/or a terminator.

6. The method according to any of the preceding claims 3 to 5, **wherein** a vector comprising the gpd, pcarB, pcarRA and/or ptef1 promoter and/or the trpC terminator is employed in the transformation (i).

7. The method according to any of the preceding claims 3 to 6, **wherein** a vector comprising a resistance gene is employed in the transformation (i).

8. The method according to claim 7, **wherein** the vector employed in the transformation (i) comprises a hygromycin resistance gene (hph), in particular from E. coli.

9. The method according to any of the preceding claims 5 - 8, **wherein** the gpd promoter has the sequence SEQ ID NO: 1.

10. The method according to any of the preceding claims 5 - 8, **wherein** the trpC terminator has the sequence SEQ ID NO: 2.

11. The method according to any of the preceding claims 5 - 8, **wherein** the tef1 promoter has the sequence SEQ ID NO: 35.

12. The method according to any of claims 6 to 11, **wherein** the gpd promoter and the trpC terminator are derived from Aspergillus nidulans.

13. The method according to any of claims 3 to 12, **wherein** the vector comprises the SEQ ID NO: 3.

14. The method according to any of the preceding claims, **wherein** the transformation (i) is carried out using agrobacteria, conjugation, chemicals, electroporation, bombardment with DNA-loaded particles, protoplasts or microinjection.

15. The method according to any of the preceding claims, **wherein** a mutagenic agent is employed in the homokaryotic conversion (ii).

16. The method according to claim 15, **wherein** the mutagenic agent employed is N-methyl-N'-nitronitrosoguanidine (MNNG), UV radiation or X rays.

17. The method according to any of the preceding claims, **wherein** the selection is carried out by labeling and/or selecting the mononuclear cells.

18. The method according to any of the preceding claims 1 - 17, **wherein** 5-carbon-5-deazariboflavin (darf) and hygromycin (hyg) or 5-fluororotate (FOA) and uracil and hygromycin are employed in the selection.

19. The method according to any of claims 3 to 18, **wherein** the vector employed in the transformation (i) includes genetic information for producing carotenoids or their precursors.

20. The method according to any of claims 3 to 19, **wherein** the vector employed in the transformation (i) includes genetic information for producing carotenes or xanthophylls.

21. The method according to any of claims 3 to 20, **wherein** the vector employed in the transformation (i) includes genetic information for producing astaxanthin, zeaxanthin, echinenone, β-cryptoxanthin, andonixanthin, adonirubin, canthaxanthin, 3-hydroxyechinenone, 3'-

hydroxyechinenone, lycopene, β-carotene, α-carotene, lutein, phytofluene, bixin or phytoene.

22. A method for providing at least one highly pure carotenoid and a foodstuff comprising carotenoid-producing organisms and at least the one carotenoid, which method comprises, after cultivation of carotenoid-producing organisms of the Blakeslea genus, the following steps:

I) removal of the biomass,

IA) optional washing of the biomass with a solvent in which carotenoids are not soluble, in particular water,

IB) sterilization and cell disruption of the biomass,

IC) optional drying and/or homogeneous distribution, and

II) partial extraction of the carotenoids from the disrupted biomass by means of a carotenoid-dissolving solvent and separation of said solvent from said biomass,

IIA)

1) removal of residual solvent from the carotenoid-containing biomass,

2) optional homogeneous suspension of the biomass, with a biomass solid content of > 10,

3) drying of the biomass or suspension for producing the foodstuff,

IIB)

1) crystallization of the carotenoids from the solvent used and isolation of the carotenoid crystals, in particular by filtration.

23. The method according to claim 22, **wherein** the at least one carotenoid is selected from the group consisting of carotenes and xanthophylls.

24. The method according to claim 22 or 23, **wherein** the at least one carotenoid is selected from the group consisting of astaxanthin, zeaxanthin, echinenone, β-cryptoxanthin, andonixanthin, adonirubin, canthaxanthin, 3-hydroxyechinenone, 3'-hydroxy-echinenone, lycopene, β-carotene, lutein, phytofluene, bixin and phytoene.

25. The method according to any of claims 22 to 24, **wherein** the at least one carotenoid is astaxanthin, zeaxanthin, *bixin* or phytoene.

26. The method according to any of claims 22-25, **wherein** sterilization and cell disruption are carried out using steam or microwave radiation.

27. The method according to any of claims 22-26, **wherein** the carotenoids are extracted from the biomass using

dichloromethane or supercritical carbon dioxide or tetrahydrofuran.

28. The method according to claim 27, **wherein** the carotenoids dissolved in supercritical carbon dioxide are isolated directly or are taken up in dichloromethane.

29. The method according to any of claims 22-28, **wherein** the carotenoids are extracted from the biomass in a one-stage or, if appropriate, multistage process.

30. The method according to any of claims 22-29, **wherein** solvents are removed from the biomass in step IA1) using steam distillation.

31. The method according to any of claims 22-30, **wherein** drying in step IIA3) is carried out using spray drying or contact drying.

32. The method according to any of the preceding claims, **wherein** crystallization in step IIB1) is carried out by replacing the solvent gradually with a solvent in which carotenoids are not soluble.

33. The method according to claim 32, **wherein** the solvent used is replaced with water or with a lower alcohol, in particular methanol.

34. The method according to claim 13, **wherein** the genetically modified organism of the Blakeslea genus can be produced by transformation with a vector which has a sequence from the group consisting of SEQ ID NO: 37 - 51 and 62.

35. A method for producing a foodstuff comprising organisms of the Blakeslea genus and at least one carotenoid, which method comprises, after cultivation of carotenoid-producing organisms of the Blakeslea genus, the following steps:

I) homogeneous suspension of the solids of the culture broth,

and

IIA) for a biomass solid content of the culture broth of > 2%:

1) optional concentration of the culture broth to give a solid content of < 50%, and

2) drying of the culture broth to produce the foodstuff,

or

IIB) for a solid content of < 2% of the culture broth,

1) concentration of the culture broth to give a solid content of > 2% and < 50%, and

2) drying of the suspension to produce the foodstuff,

or

IIC) independently of the solid content of the culture broth,

1) removal of the biomass,

2) optional washing of the biomass with solvents in which carotenoids are not soluble, in particular water,

3) sterilization and cell disruption,

4) optional drying and homogeneous distribution,

5) partial extraction of the carotenoids from the biomass using a carotenoid-dissolving solvent,

5a) removal of the carotenoid-containing biomass from the carotenoid-containing solvent,

5b) removal of residual solvent from the biomass, and

5c) drying of the biomass to produce the foodstuff,

6) crystallization of the carotenoids from the solvent used in 5a) and isolation of the carotenoid crystals, in particular by filtration.

36. The method according to claim 35, **wherein** the at least one carotenoid is selected from the group consisting of carotenes and xanthophylls.

37. The method according to claim 35 or 36, **wherein** the at least one carotenoid is selected from the group

consisting of astaxanthin, zeaxanthin, echinenone, β-cryptoxanthin, andonixanthin, adonirubin, canthaxanthin, 3-hydroxyechinenone, 3'-hydroxyechinenone, lycopene, β-carotene, lutein, bixin and phytoene.

38. The method according to any of claims 35-37, **wherein** the at least one carotenoid is astaxanthin, zeaxanthin, *bixin* or phytoene.

39. The method according to any of claims 35-38, **wherein** sterilization and cell disruption in step II3) are carried out using steam or microwave radiation.

40. The method according to any of claims 35-39, **wherein** the carotenoids are extracted from the biomass in step IIC5) using dichloromethane or supercritical carbon dioxide.

41. The method according to claim 40, **wherein** the carotenoids dissolved in supercritical carbon dioxide are isolated directly or are taken up in dichloromethane.

42. The method according to any of claims 35-41, **wherein** the carotenoids are extracted from the biomass in a one-stage or, if appropriate, multistage process.

43. The method according to any of claims 35-42, **wherein** solvents are removed from the biomass in step IIC5b) using steam distillation.

44. The method according to any of claims 35-43, **wherein** drying in any of steps IIA1), IIB2) and IIC5c) is carried out using spray drying or contact drying.

45. The method according to any of claims 35-44, **wherein** crystallization in step IIC6) is carried out by replacing the solvent gradually with a solvent in which carotenoids are not soluble.

46. The method according to claim 45, **wherein** the solvent used is replaced with water or with a lower alcohol, in particular methanol.

47. The method according to any of claims 35-46, **wherein** the genetically modified organism of the Blakeslea genus can be produced by transformation with a vector which has a sequence from the group consisting of SEQ ID NO: 37 - 51 and 62.

48. A foodstuff, in particular animal feedstuff, which can be produced by any of the methods of claims 1 to 47.

49. A food supplement, in particular animal feed supplement, which can be produced by any of the methods of claims 1 to 47.

50. A method according to any of claims 1-49, wherein foodstuff and animal feedstuff can be obtained from a fermentation.

51. The method according to any of claims 1-49, wherein food supplement and animal feed supplement can be obtained from a fermentation.

52. The method according to any of claims 1-49, wherein at least two products of the group consisting of foodstuff, food supplement, animal feedstuff and animal feed supplement can be obtained from a fermentation.

53. The use of the carotenoids obtainable by a method of claims 1 to 14 for producing cosmetic, pharmaceutical, dermatological preparations, foodstuffs, food supplements, animal feedstuff or animal feed supplement.